

A Device for Prophylaxis of Acoustic Trauma

RICHARD THOMAS BARTON, M.D., Beverly Hills

THAT ACOUSTIC TRAUMA is an important industrial problem is obvious to any otologist, yet prophylaxis of injury of that kind has been extremely perplexing. Ear plugs of various types have been introduced but they have not been widely used as prophylactic devices because they impair the hearing for conversational voice while protecting against the concussion of occupational noises. Other "ear protectors" have afforded little or no protection.

A study was made to determine the possible prophylactic effectiveness of the Lee Sonic Ear-Valv,[®] which is designed to control the amount of sound entering the ear, admitting conversational tones but barring damaging noises. The ear valve is diagrammed in Figure 1 and the component parts are shown in Figure 2.

The portion that is inserted is a hollow stem set in an ear-stopper made of silicon. It is designed to fit snugly but comfortably into the ear canal, to hold the unit in the ear and to direct sound through the hollow stem. The cylinder contains the many parts of the mechanism for controlling sound pressure, and in it is a small opening for the sound waves to

• Tests were made to determine whether protection against acoustic trauma was afforded by an ear-plug containing a valve designed to close under pressure of intensive noise.

The hearing acuity of 34 persons was determined before they participated in target practice on a pistol firing range. Eighteen of them then wore the ear-plugs on the range and 16 did not. Hearing acuity was again determined after the target practice and it was noted that the loss of acuity was considerably less in subjects who had worn the plugs than in those who had not.

enter. The intensity of sound is controlled by a valve which is suspended equidistant between two seats by two concentric springs.

This valve divides the passage through which sound must pass, so that the sound waves move the valve back and forth between the seats. The louder the sound pressure, the more the valve is displaced. Since sound waves are alternate, this displacement

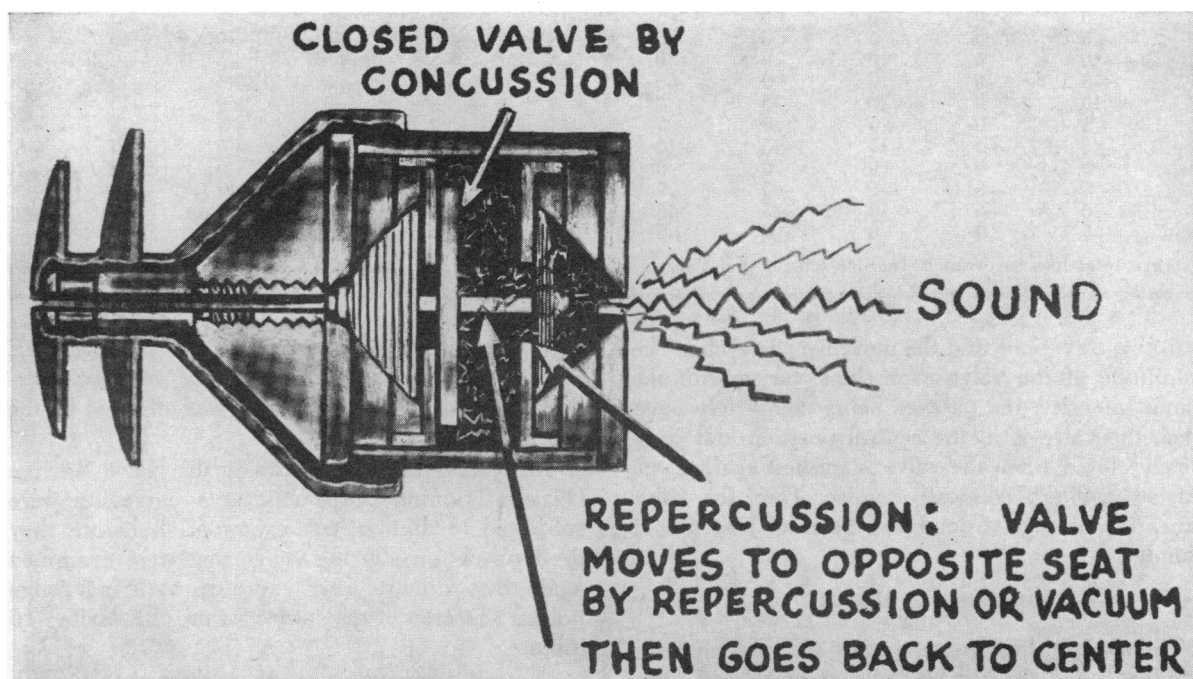


Figure 1.—Diagram illustrating the movement of the valve with diphasic sound waves.

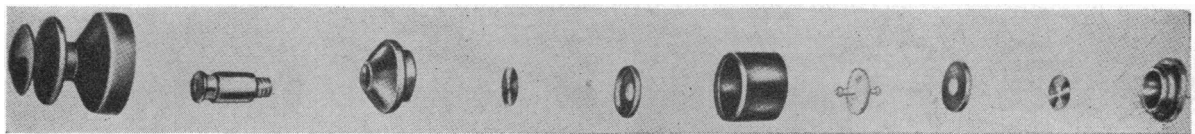


Figure 2.—The component parts and full assembly of the Ear-Valv.

TABLE 1.—Audiometric Disparity in Hearing After Firing Compared with Test Before Firing

Without Ear-Valv

	Decibels										
	125	250	500	1000	2000	3000	4000	6000	8000	12000	Totals
1.....	-5	0	+5	0	-5	-10	-25	-35	-35	-30	-140
2.....	+5	+5	+5	+10	+15	-10	0	-15	-20	-35	-35
3.....	0	+5	+5	+15	-5	-5	0	-15	-25	0	-25
4.....	-10	-5	+5	+5	0	0	-10	-20	-30	-25	-90
5.....	-5	0	-5	0	0	0	-5	-5	0	-15	-35
6.....	0	+5	+5	+5	-5	0	-15	-15	-50	-20	-90
7.....	-10	-5	-5	-10	-10	0	-20	-10	-20	-10	-100
8.....	0	-5	-5	-5	-5	-10	-5	-25	-25	-35	-120
9.....	-5	-5	-5	-5	-5	-5	0	-10	0	0	-40
10.....	-10	-5	+5	+5	0	+5	-35	-10	-15	-15	-75
11.....	+5	+5	+5	+5	+5	+10	0	0	-10	0	+25
12.....	+10	+15	+10	+5	+10	0	0	+5	+5	0	+60
13.....	-5	0	-5	-10	0	+5	0	0	-5	-10	-30
14.....	+5	0	-5	-5	0	0	+5	-5	0	-5	-10
15.....	-10	-10	0	-5	0	0	-5	-5	-5	-10	-50
16.....	+5	+5	+5	0	0	-10	-10	0	-15	-20	-40
Average total loss in decibels (unprotected subjects).....											49.7

With Ear-Valv

	Decibels										
	125	250	500	1000	2000	3000	4000	6000	8000	12000	Totals
1.....	0	0	+10	0	-5	-5	0	+5	-5	-10	-10
2.....	+10	+10	+5	+5	+5	0	0	+10	-25	0	+20
3.....	+5	+10	-5	-5	0	+5	0	-5	+5	-15	-10
4.....	0	+10	+10	0	0	+5	0	-5	0	+10	+35
5.....	0	0	0	0	+5	+5	+15	0	-5	-30	-10
6.....	+10	0	+5	+5	+5	+5	0	+5	-5	-10	-20
7.....	0	0	0	-10	-5	-5	0	0	0	-5	-25
8.....	0	+20	+25	+5	+5	-15	-10	-10	-5	+5	+20
9.....	+5	0	-5	+5	-5	-5	0	-10	-10	-15	-40
10.....	-10	0	0	0	0	+5	-5	+5	+5	-10	-10
11.....	-5	0	0	0	+5	+5	-5	+5	+5	-10	-10
12.....	+10	0	+10	-5	0	0	0	0	0	-15	-20
13.....	+5	0	+5	0	+5	+5	0	+5	+5	-5	+25
14.....	+5	+5	+15	+15	+10	0	+10	0	+5	0	+65
15.....	0	0	0	0	0	0	+5	-5	0	+10	+10
16.....	-5	-5	-5	-5	0	+5	-5	-5	-10	+5	-30
17.....	-10	-5	-10	-5	+5	+5	+5	-10	-5	+5	-25
18.....	-5	0	0	0	+5	+5	0	0	0	0	-5
Average total loss in decibels (subjects using Ear-Valv).....											1.9

is in two directions and the movement is cyclic. The amplitude of the valve excursions varies with the sound intensity, the passage being completely open when the valve is in the central position and completely closed when the valve is pushed against one seat by a sharp concussive noise. Thus the valve closes the passage to loud and harmful pressure of sound.

METHODS OF TESTING

The testing of ear protectors by physical methods is difficult and the results controversial. Most techniques employ pure tones. However, since for prac-

tical purposes the concern is with "white noise," it was decided to use a "field testing" method to determine what protection, if any, was afforded by the Lee Sonic Ear-Valv.

Thirty-four undergraduates in the Naval Reserve Officers Training Corps unit at a university were subjected to audiometric examination before they fired pistols on a firing range and were examined again five minutes after exposure to firing range noises. Eighteen of the subjects wore the device; 16 did not.

The test weapons were .45 caliber pistols. Each subject fired ten rounds in the subterranean firing

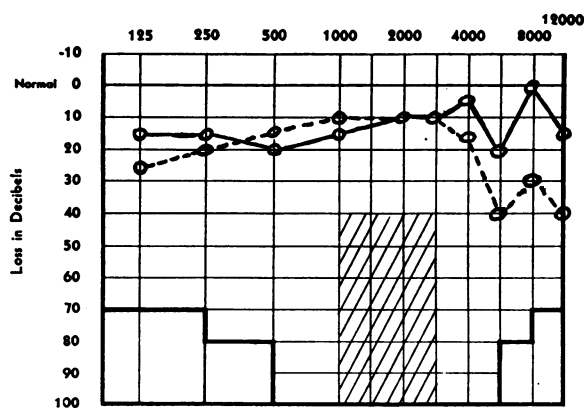


Chart 1.—Audiogram considered typical from the control group not wearing the Ear-Valv. Solid line represents hearing before firing and the dotted line represents hearing after. The two tests were essentially the same except for the characteristic loss in the high tones due to acoustic trauma. This chart was of the tests of Subject No. 4 in the control group.

range of the armory on the university campus. The noise level at the time of firing was measured to exceed 120 decibels. No spectral analysis of the noise was attempted. All the patients had been otoscopically examined before the tests and were observed to have normal membrana tympani. They were examined again after firing, and in neither group was there any visual evidence of trauma to the ear.

All audiograms were taken on one recently-calibrated audiometer, all by the same audiometrist and all under the same conditions. Three threshold determinations were made at each point on the audiogram. All test subjects were exposed to exactly the same amount of gunfire for sixty seconds, and all were familiar with the audiometer, having been tested previously for midshipman examinations. They were all between eighteen and twenty-one years of age.

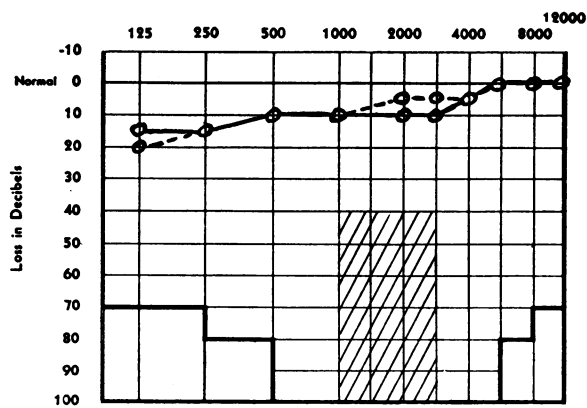


Chart 2.—Audiogram considered typical from the protected group wearing the Ear-Valv. The two tests are essentially the same demonstrating no loss after exposure to acoustic trauma. This chart was made from the results of tests of Subject No. 18 in the protected group.

RESULTS

The results of audiometric tests before and after firing are shown in Table 1, and the greater loss of hearing acuity among subjects who did not wear the Ear-Valv than among those who did indicates the device does protect against the trauma of intense sound. It was spontaneously reported by many of the subjects that there was pronounced relief from the usually painful noise of the .45 caliber pistol.

The accompanying audiograms (Charts 1 and 2) are considered typical of the tests with and without the Ear-Valv.

The Lee Sonic Ear-Valv is manufactured by the Sigma Engineering Company, 1491 North Vine Street, Hollywood 28, California.

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9754 Wilshire Boulevard.